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VICIOUS CIRCLES ASSOCIATED WITH DISORDERS OF THE HEART

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LOGICIANS apply the expression "vicious circle" to a fallacy (*argumentum in circulo*) in which a proposition is used to establish a conclusion and is afterwards proved by that same conclusion, so that, as in a circle, there is no starting point. Many years ago the expression was transferred into medical nomenclature to indicate a morbid condition in which cause and effect act reciprocally on each other.[†]

Vicious circles are very numerous and play a more important part in the processes of disease than has hitherto been recognized. Many of them result from a failure of Nature's efforts at compensation, and are therefore of interest both to clinician and to pathologist. Elsewhere¹ I have suggested a classification based on etiology (organic, mechanical, chemical, infective, neurotic circles, etc.), and have given examples of vicious circles affecting the various organs of the body. The study of the subject as affecting a single organ possesses even greater advantage, since the inter-relations of such circles come more clearly into view.

The organ best suited for the purpose is probably the heart, since the vital and mechanical phenomena presented by cardiac lesions are unique in their variety and interest. The heart, moreover, has maladies of local origin and maladies of peripheral origin, thus supplying an extensive field for observation. At the same time,

* Read before the Reading Pathological Society.

† Dr. (afterwards Sir H.) Holland, F.R.S. (*Medical Notes and Reflections*, p. 99), gives an excellent description of a vicious circle in 1839, and there are probably still earlier references.

modern methods of physical diagnosis have thrown so much light on the pathology of cardiac lesions that probably nowhere else can that interaction of forces with which we are concerned be so readily studied.

For the sake of clearness vicious circles associated with disorders of the heart may be arranged in the following groups:

- Group I.—Circles associated with the myocardium.
- Group II.—Circles associated with the endocardium.
- Group III.—Circles associated with the pericardium.
- Group IV.—Circles associated with neuroses.
- Group V.—Circles associated with a fall in blood pressure.

GROUP I.

Circles Associated with the Myocardium.

Striking examples are met with as a result of arterial hypertonus in the pulmonary and the systemic circuits. Thus in the case of the *right* side of the heart various conditions, such as chronic bronchitis and emphysema, increase the resistance to the flow of blood through the lungs and necessitate greater driving power by the right ventricle, leading to its hypertrophy and dilatation. These changes are at first compensatory and salutary. But as time goes on and the compensation begins to fail, dilatations gains on hypertrophy, leading to congestion of the venous system and to interference with the functions of digestion, absorption, elimination and sanguification. The unfortunate myocardium, already labouring under special difficulties *a fronte*, is poisoned by the products of metabolism, which sap its nutrition and aggravate the weakness and dilatation. A vast vicious circle is established, embracing the great organs of the body.² The weak and dilated ventricle and the increased resistance to the pulmonary circulation also act and react injuriously on each other, setting up a second circle of evil omen.

Even commoner are the conditions which cause a high arterial tension in the systemic circulation, and throw excessive work on the *left* side of the heart. Amongst them are renal disease, gout, lead poisoning, and defective metabolism. The toxic products in the blood set up a spasm or hypertonic condition of the capillaries and arterioles, leading to increased resistance, which in turn requires a more forcible cardiac systole, so as to force the blood through the distant ramifications of the vascular system. The consequent rise in the blood pressure leads

to hypertrophy of the muscular structures engaged, which hypertrophy reacts on and raises the blood pressure.³ Thus the antagonistic forces of arterial hypertonus and muscular hypertrophy come into operation and complete the morbid circle. When, as often happens, the degenerative processes of arterio-sclerosis are superadded to the muscular hypertrophy, obliterative changes in the coronary arteries are apt to ensue, interfering with the nutrition of the myocardium and lowering its vitality; especially will this happen if the blood is impure in quality as well as deficient in quantity. The consecutive weakening of the myocardium in turn impairs the coronary circulation, a second circle being thus established. As the dilatation and enfeeblement of the left ventricle increase, the venous stasis is manifested on the right side of the heart and produces the sequelae already mentioned in connexion with failure of the right ventricle. Thus no less than three forms of vicious circles may arise at different stages of arterio-sclerosis, ending in grave cardiac disorganization.

The right and left sides of the heart have hitherto been considered separately as affected by disease of the pulmonary or systemic areas. But in point of fact the changes described usually affect both sides simultaneously, although not to the same extent. While this is partly due to the close anatomical and physiological relations, a special cause for the bilateral dilatation and weakening lies in a vicious circle, which may be established between the two sides of the heart, as has been pointed out by West.⁴ When the right side of the heart fails, the whole of the coronary veins, which open into the right auricle, soon become engorged. Hence result impaired circulation through, and impaired nutrition of, the whole heart. As the left ventricle becomes implicated its driving power is diminished, giving rise to pulmonary congestion and defective aeration of the blood. Further, the circulation through the coronary arteries is weakened, another source of general cardiac weakness being added. In a similar way dilatation commencing on the left side involves the right, and so it comes about that right-sided failure involves the left side, and left-sided failure involves the right, the degree depending on the seat of the primary lesion, and unless the vicious circle can be broken, a fatal result is only too probable.

Anaemia, when associated with fatty or other kinds of degeneration of the cardiac walls, frequently sets up a vicious circle. For the insufficient *vis a tergo*, the sluggish

renewal and purification of blood and the hampered digestion and absorption of food tend to increase the anaemia, while the anaemia in its turn exerts a most prejudicial effect on the myocardium by interfering with the metabolism of its cells, and accelerating the degeneration. Thus cause and effect proceed *pari passu*, acting and reacting on each other. These degenerations of the myocardium may also be prejudicial, as already mentioned in connexion with arterio-sclerosis, by obstructing the orifices of the coronary arteries. Through such obstructed vessels the supply of blood to the walls of the heart is more or less completely cut off, leading to further degeneration and increased stenosis. Thus, what with a degenerating myocardium and a defective blood supply, a complex series of interactions is set up, which medicine can do little to unravel, and which, sooner or later, ends in a complete breakdown.

In obese persons some interesting reciprocal relations may be observed. The primary effect of obesity is to induce a certain amount of cardiac hypertrophy, followed in due course by cardiac dilatation, dyspnoea on exertion, disinclination for active exercise, and eventually by increased obesity. The obesity, in fact, is both cause and effect of the heart lesion.

In general practice a condition is commonly met with where enfeebled health, due to overwork or other sources, leads to an irregular and weak action of the heart, and hence to oedema and congestion of the viscera. Dyspeptic disorders, such as flatulent distension, follow and further depress the heart, a reciprocal relationship being established between these organs.

Chronic alcoholism in its later stages leads to a vicious circle by causing dilatation of the heart and enfeebling its contractile power, effects with which are commonly associated anorexia, palpitations, and a general want of energy. These symptoms only too often drive the victim to further indulgence, and thus intensify the original mischief, until the inevitable Nemesis of shattered health ensues.

Jürgensen⁶ points out how close is the connexion between a feeble, dilated ventricle and impaired nutrition of the myocardium, and how the resultant vicious circle may be the harbinger of death.

Je unzureichender die Herzthäufigkeit, desto unzureichender seine Ernährung, und damit nimmt seine Ermüdbarkeit und Dehnbarkeit zu. Es ist also möglich, dass der Circulus vitiosus sich schliesst, d. h. eine einmal entstandene, durch

Ermüdung ihrer Muskeln herbeigeführte Erweiterung der Kammer kann nicht mehr beseitigt werden, sie muss zum Herzstillstand führen.

This condition may arise through a variety of causes which diminish the cardio-motive force, such as sudden strain, influenza, beri-beri, or other toxic agencies. The progressive accumulation of residual blood, which over-distends the ventricle and leads to its further weakening, is an additional source of danger.

Acute disease, such as croupous pneumonia, may be complicated by a vicious circle, the lungs and the heart being the organs reciprocally involved. The cardiac dilatation and failure so often associated with pneumonia result partly from poisoning and exhaustion of the nerve centres, and partly from the mechanical effort to overcome the increased obstruction in the pulmonary circuit. In either case the failure of the heart reacts unfavourably on the lungs by retarding the pulmonary circulation, which retardation throws an extra burden on the ventricle, whose nutrition is impaired and whose contractile power is unequal to the demands upon it. Thus heart and lungs embarrass each other, and the vicious circle is frequently only interrupted by death. A closely allied condition, which need not be more fully described, occurs in acute bronchitis.

GROUP II.

Circles Associated with the Endocardium.

Chronic valvular lesions, accompanied by compensatory changes, sooner or later, when the compensation fails, set up such vicious circles as have already been described in Group I in connexion with dilatation of the heart. For the secondary changes in the great viscera, including the myocardium, are the same whether the dilatation has resulted from peripheral disease such as a chronic nephritis, or from such a cardiac lesion as aortic obstruction. Further reference to such vicious circles is therefore needless.

There are, however, other circles specifically associated with valvular lesions. In the words of Bouillaud,⁶ "Diverses maladies du cœur peuvent elles-mêmes devenir causes déterminantes d'autres maladies de cet organe," and it is in connexion with these secondary disorders that reciprocal relations are met with. Such, for example, occur in cases of aortic regurgitation, where the state of repletion of the coronary arteries lasts a shorter period

than normal, owing to valvular insufficiency. Hence follow impaired nutrition of the cardiac walls, lessened working capacity, increased regurgitation, and consequently a still less adequate repletion of the coronaries, culminating occasionally in sudden death.

Another illustration is seen where tricuspid regurgitation results from the dilatation of the right ventricle secondary to mitral obstruction. For a time the reflux may relieve the overloaded ventricle, but ultimately its effect is to further weaken the power of the ventricle to overcome the obstruction. Again, when mitral regurgitation is consequent on aortic regurgitation or obstruction (owing to progressive dilatation of the ventricle and auriculo-ventricular orifice), a morbid circle arises through the reciprocal effect on one another of the aortic lesion and the mitral regurgitation.

In the case of malignant or septic endocarditis an infective vicious circle is frequently started by the micro-organisms circulating in the blood. These microbes lead to vegetations and erosions in the endocardium, especially that lining the valves, and from these vegetations showers of infective emboli are detached in their turn, carrying infection far and wide.

Another circle is established when an attack of endocarditis bequeaths permanent valvular mischief. The patient does not die, but remains an invalid, the *sanatio incompleta* being shown by a disposition to relapse, by a diminished power of resistance to fresh attack. "As a taper just blown out will snatch the flame from the torch that scarcely touches it," so readily is the endocardiac mischief rekindled. Thus the valvular mischief and the lowered resistance act and react on each other, often leading in time to extensive cumulative mischief.

The morbid circle met with in congenital heart disease is most appropriately placed in this Group, since such disease often arises from imperfections either of the valves or of the septa caused by fetal endocarditis. The venous stasis associated with the cyanosis and the resultant convulsions constitute the two factors in the circle which frequently constitutes a grave menace to life.

When valvular lesions occur in such persons as navvies or coal-heavers, whose laborious daily work cannot be exchanged for a lighter occupation, disastrous consequences generally follow much earlier than they would do were the environment more favourable to compensation. Many a life has been sacrificed where poverty or adverse

fortune compelled a life of toil. The labour aggravates the heart lesion, the heart lesion (owing to associated dyspnoea and palpitation) makes the daily task relatively, if not absolutely, harder than it would otherwise be.

GROUP III.

Circles Associated with the Pericardium.

Attention has already been directed to the vicious circle met with in persons who have recovered from endocarditis, but in whom, unfortunately, there has been *no restitutio ad integrum*. Recovery has been at the cost of some valvular lesion, and of a diminished power of resistance. A similar condition not infrequently follows pericarditis. The acute attack subsides, but leaves behind a liability to recrudescence; the damaged pericardium on trivial exposure is attacked afresh, and each time the damage increases, until the pathological changes due to the several attacks may be enormous. The primary lesion has led to the second attack; the second attack has aggravated the primary lesion.

Another vicious circle is set up when acute pericarditis leads to copious effusion. The effusion compresses the great vessels at the roots of the lungs, as well as those of the heart and pericardium, and thus hampers the circulation. The hampering of the circulation increases the effusion. A parallel condition is associated with pleuritic effusion, and the improvement that so often follows paracentesis, even when only a small quantity of fluid is removed, is probably due to the breaking of the circle by such removal.

Non-inflammatory dropsy of the pericardium or hydropericardium, due to venous stasis in the coronary veins or to some other cause, acts in a similar manner. The dropsy, often part of a general condition, in its turn aggravates the disease from which it sprang. In the words of Gibson:³

Hydropericardium may be said to step in as the closing link of a pathological chain, and once it has made its appearance it unites with the other morbid conditions to form a vicious circle of fatal import.

GROUP IV.

Circles Associated with Neuroses.

A lamentable vicious circle belonging to this Group is set up when an inexperienced practitioner erroneously

diagnoses a "weak heart," and excites in his patient an ever-present dread of serious illness or immediate death. The exaggerated fears, like Damocles's sword, overshadow life, and render all enjoyment impossible. The constant direction of the mind to the one organ leads to morbid consciousness of trivial sensations, to such unwholesome régime as to induce a feeble and flabby heart, which on the slightest provocation reacts on the neurotic condition. An illustration is given by Sir Douglas Powell:⁹

The patient was a young married woman, formerly of active, energetic, useful habits, whose doctor had diagnosed a weak heart. She had been taking the utmost care of a healthy organ ever since, resting half the day, never even walking upstairs, until she became fat, breathless, anaemic, and miserable. Many months would elapse before she could be fully weaned back to her former healthy activity, if indeed recovery were at all possible.

Huchard¹⁰ has drawn attention to a vicious circle associated with angina pectoris.

Les angineux tournent souvent dans un cercle vicieux morbide. Le repos leur est formellement prescrit; on leur défend l'exercice . . . et à la faveur de ce repos systématique, de cette immobilité prolongée, ils ont une tendance à faire du tissu adipeux, à devenir obèses; bientôt, la circulation intra-abdominale va se ralentir . . . et le cœur . . . va être bientôt insuffisant à la tâche. De la sorte, il y a des angineux qui se trouvent, à la longue, singulièrement aggravés par cet embarras circulatoire dû au manque d'exercice.

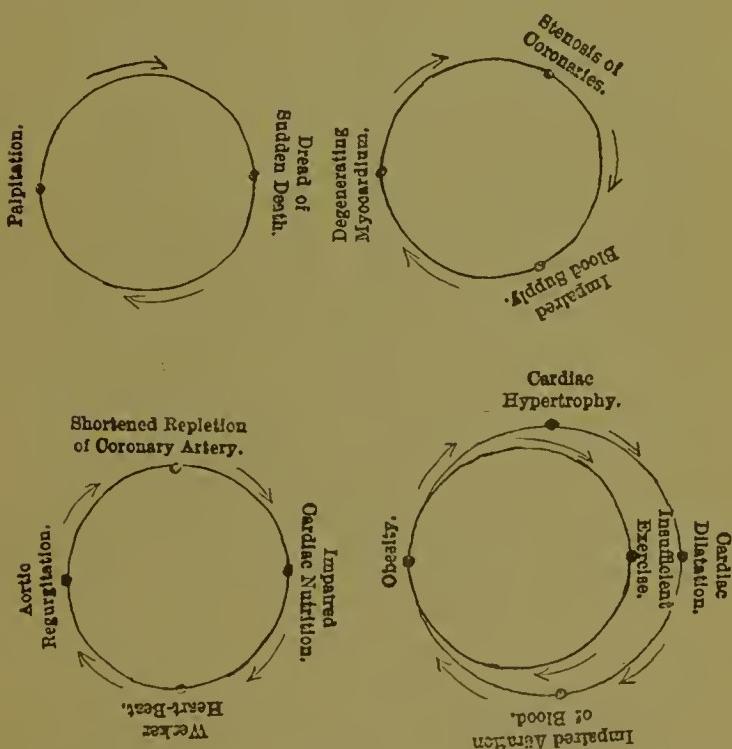
When an unduly neurotic temperament is associated with heart disease, another variety of circle may be established, if the true state of the heart is revealed. Equanimity is all-important for the processes of compensation and repair, and its absence may seriously militate against recovery. In the words of Fraentzel:¹¹

Dies Wissen ist oft viel schlimmer als die Krankheit selbst.

In other patients of a similarly neurotic temperament such a functional disorder as palpitation may start the train of symptoms. The palpitation may be so violent as to cause an apprehension of sudden dissolution, and this apprehension in turn keeps up, and indeed intensifies, the palpitation. The result is a concatenation of symptoms causing grievous distress.

A different form of circle may be established when an unsound heart is injudiciously "coddled"—that is, treated by excessive mental and physical repose, perhaps

even pinned to bed! Such a régime keeps the heart feeble, and the over-rested heart calls for more rest. What procedure is more likely to wreck all chance of recovery! Yet another circle, sometimes ending fatally, may be set up when in heart disease an attack of vomiting is brought on either through the pneumogastric nerves or as a result of mechanical congestion of the stomach. The vomiting may depress the circulation and vital powers to such an extent as to aggravate the



Diagrams showing the analysis of vicious circles into component factors. The fourth figure represents the double circle of obesity.

cardiac condition or accelerate the end. Lastly, when from some temporary cause an intermittent action of the heart has set in, a vicious circle may result from a mere repetition of the intermittence. The habit of intermitting leads to an exaggerated irritability of the cardiac nerve centres, causing a continuance of the abnormal action even after the removal of the primary cause.

GROUP V.

Circles Associated with a Fall of Blood Pressure.

Vicious circles have already been described in which the blood pressure was higher or lower than normal, more especially in connexion with diseases of the myocardium. But it will be convenient to group under a separate heading some other circles in which a rapid fall of pressure, either of central or peripheral origin, is a dominant feature. During health the bulbar centres are excited to increased or diminished activity, according as arterial pressure falls or rises, this compensatory mechanism maintaining the cerebral circulation. But when those centres are paralysed, exhausted, or inhibited, the vasomotor mechanism is thrown out of gear, and a diminished blood supply weakens instead of stimulating the centre. A good example is seen in cases of severe surgical shock causing paralysis of the bulbar centres. As a result of the paralysis the blood pressure falls, partially emptying the cardiac and cerebral vessels. Less blood is pumped up to the brain, and the bulbar centres are still further weakened. Thus cause and effect act and react on each other, leading, when the shock is severe, to disastrous consequences. A similar condition occasionally accompanies the administration of chloroform, which not only acts on the bulbar centres, but also causes dilatation of the heart, and further interferes with the compensatory mechanism. Probably syncope and church faints are due to a like interference with the vasomotor mechanism.

Cohnheim¹² has pointed out how prolonged pyrexia, while increasing the demands on the heart, steadily reduces its motive power, owing partly to changes in the cardiac muscle, partly to toxins and to nervous exhaustion. This reduction in power causes the arterial pressure to fall, and as a result the functions of the digestive, respiratory and nervous tissues suffer. Products of metabolism accumulate in the blood and further depress both cardiac activity and blood pressure. Not infrequently does the vicious circle thus established end in the collapse which is so often the forerunner of death. An allied condition is met with in extreme tachycardia, where the pulse-rate may reach 250 or even 300 per minute and the pressure fall from 15 to 5 cm. Hg. In such cases the tachycardia and the lowered pressure are often reciprocally correlated. As Huchard¹³ has expressed it:

Le rapprochement des révolutions cardiaques empêche à la fois la réplétion ventriculaire qui n'a pas le temps de se produire et l'expulsion du sang dans le système artériel. C'est là un cercle vicieux d'où l'on ne peut faire sortir le malade qu'en agissant directement sur la tension artérielle trop abaissée.

An excellent illustration of an artificial circle belonging to this Group may be mentioned here, although happily its interest is chiefly historical, since it belongs to the days when venesection was regarded as a panacea for almost every ailment, acute or chronic. The evidence is only too clear that *venesectio ad mortem* was no uncommon occurrence, death being erroneously attributed to the illness instead of to loss of blood. The custom was to bleed until the patient became faint, when recovery was allowed to take place. In the case of many diseases, especially such as are accompanied by fever or pain (for example, pneumonia, peritonitis, typhoid), some remission of the symptoms followed recovery from the faintness, a remission which was hailed as evidence of the beneficence of the operation, and led to its being repeated again and again, if the original fever or pain recurred.

When, however, blood is drawn *pleno rivo*, many of the symptoms produced (for example, palpitation, vertigo, violent headache, jactitation, convulsions, coma) resemble those of inflammatory disorders, and were attributed to a recrudescence of the original mischief, although really due to anaemia. Unwary practitioners were easily led astray. In the *Lancet* of 1827¹⁴ an illustrative case is given which may be briefly summarized:

A man fell from a scaffold and fractured several ribs. On reaching St. Bartholomew's Hospital early on a Friday morning he was bled 18 oz., and at noon 20 oz. more. The next day a further 18 oz. were taken, and on the following day 18 oz. at noon and 18 oz. in the evening. On Monday the pulse was small and jerking, but very compressible. This condition was regarded as "indicative of inflammation and not resulting from loss of blood or haemorrhagic irritation." Accordingly bleeding was again ordered to the extent of 18 oz. The dresser in charge of the case, however, alarmed by the condition following the loss of a few ounces, desisted from drawing any more. Nevertheless, when about two hours later two surgeons saw the man in consultation, they ordered 20 oz. more to be drawn. After this the pulse became a mere flutter, death taking place a few hours later.

Many such cases could be quoted in which cause and effect were inextricably mixed up, the venesection being repeated to remove the very symptoms it had produced.

TREATMENT.

A vicious circle can be analysed into two or more factors which act and react on each other to the progressive injury of the patient, and their recognition is essential to rational treatment. The graphic method of analysis, as shown in the annexed diagrams, will often assist in defining the factors.

As regards treatment, most of the recognized principles of cardiac therapeutics apply. Some special points, however, deserve attention.

1. The exciting cause must be sought. Sometimes this is obvious—for example, when rheumatic fever has led to the vicious circle of aortic regurgitation and cardiac ischaemia, or when pneumococcal infection has led to that of pneumonia and heart failure. At other times close investigation of detail will be required. In law "*de minimis non curat lex*" may be pardonable; but "*de minimis curat medicus*" is a safer motto for the physician dealing with obscure disease. Thus an ill-ventilated gas-lit office or over-indulgence in tobacco may so depress the heart, even when organically sound, that the pulse becomes feeble and intermittent and life miserable and useless, the heart and general health depressing each other. Removal of the exciting cause may in itself ensure recovery.

2. It is frequently desirable to actively treat *each* of the several factors concerned. In pneumonia, for example, the practitioner who merely watches the lungs, and is oblivious of the more important cardiac signs, loses the best chance of helping his patient weather the storm. The finger on the pulse is as important as the stethoscope on the chest. Again, if in the rush of the out-patient room the unsound heart of a coalheaver is stimulated with digitalis and strychnine, while no steps are taken to lessen the daily toil that is hindering Nature's efforts at compensation, the remaining span of life will probably be but brief.

3. Where there is a choice of treatment, each practitioner must attack what appears to him the *locum minor is resistentiae*. Hence results a varying *modus operandi* for the same disorder, a variety which puzzles the patient, especially if several doctors are consulted in succession. An example will illustrate the point: A stockbroker of advancing years suddenly collapses, and is found to be suffering from insomnia, failing heart, crepitaculum over both bases, albuminuria, general anorexia and dyspepsia. One physician orders him to Switzerland, believing that

complete change of scene and air will so restore his nervous system that circulation, digestion, and renal organs will rapidly get back into working order. Another prescribes a long spell of bed. No *Stock Exchange Daily List* can worry him; recumbency will give his heart less work; the warm bed will act on the skin and relieve the kidneys; the lighter diet will facilitate the work of the stomach and liver; the improved circulation and digestion will relieve the lungs and react in favour of the heart. In brief, this treatment ensures physiological rest to brain, heart, lungs, and viscera, a change of air and scene being prescribed at a later stage. As a result of these cumulative measures, the vicious circle is converted into a healthy one, all the organs improving by degrees and helping one another in an ascending scale. Here are two methods of breaking the vicious circle, and each method would at times be most successful.

4. The close dependence of the heart on the central nervous system is shown by the existence of several vicious circles in nervous introspective patients. Oftentimes there is a baseless fear of sudden dissolution, or some trivial ailment is magnified into such importance that all useful altruistic life is ruined. Here a few well-chosen words from a trusted counsellor may sever the bonds and loose the sufferer from a state of despair. Where insomnia forms part of the neurosis, a dose of morphine may render great service, acting, in the words of Prdgyn Teale, "like a good coxswain, who rallies a crew who had been catching crabs, and makes the men pull together."

5. Many vicious circles associated with the myocardium arise from the failure of compensatory changes, as, for instance, when a salutary hypertrophy is followed by undue dilatation, caused either by degeneration of the myocardium or by the excessive work thrown on the heart. Here treatment may do much to increase the vigour of the myocardium or to lighten its load. By either one or both courses the failing compensation may be so restored as to render the heart once more equal to its task. Above all must an ample supply of pure blood be secured to the myocardium.

CONCLUSION.

Indulgence may fairly be claimed for this the first attempt to deal systematically with the vicious circles associated with a great organ such as the heart, the

capital, so to speak, of an empire with whose remotest outposts it is, for good as well as for ill, in constant communication. The subject is one which throws some fresh light on Hippocrates's aphorism:¹⁵ Συμπαθέα πάντα· κατὰ μὲν οὐλορειλίην πάντα, κάτα μέρος δὲ τὰ ἐν ἑκάστῳ μέρει μέρεα πρὸς τὸ ἔργον, that is, "the whole body sympathizes with every member, and every member with the whole throughout its structure," and emphasizes the limits that are imposed on the *vis medicatrix naturae*.

REFERENCES.

- ¹ BRITISH MEDICAL JOURNAL, 1907, vol. i, p. 1104. ² Gibson, *Diseases of the Heart and Aorta*, p. 256. ³ Broadbent, *Heart Disease*, p. 26.
- ⁴ *Diseases of the Organs of Respiration*, pp. 129, 130, 237. ⁵ Nothnagel, *Pathologie und Therapie*, vol. xv, part i, sec. 4, p. 16. ⁶ Huchard, *Maladies du coeur et de l'aorte*, vol. iii, p. 717. ⁷ Latham's Works, N.S.S., vol. i, p. 257. ⁸ *Diseases of the Heart and Aorta*, p. 386. ⁹ *Treatment in Diseases and Disorders of the Heart*, p. 15. ¹⁰ *Maladies du cœur et de l'aorte*, vol. ii, p. 199. ¹¹ *Vorlesungen über die Krankheiten des Herzens*, vol. ii, p. 42. ¹² *Lectures on General Pathology*, N.S.S., vol. iii, p. 1416. ¹³ *Maladies du cœur et de l'aortic*, vol. i, pp. 16, 17, 100. ¹⁴ *Ibid.*, vol. ii, p. 94. ¹⁵ Free translation from περὶ τροφῆς, sec. 23.